

PENT COOPERATION TRE/

From the INTERNATIONAL BUREAU

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NOTIFICATION OF ELECTION
(PCT Rule 61.2)

Date of mailing (day/month/year) 10 April 2001 (10.04.01)	To: Commissioner US Department of Commerce United States Patent and Trademark Office, PCT 2011 South Clark Place Room CP2/5C24 Arlington, VA 22202 ETATS-UNIS D'AMERIQUE in its capacity as elected Office
International application No. PCT/US00/17202	Applicant's or agent's file reference 1446PCT
International filing date (day/month/year) 23 June 2000 (23.06.00)	Priority date (day/month/year) 24 June 1999 (24.06.99)
Applicant GADGIL, Prasad, Narhar	

1. The designated Office is hereby notified of its election made:

in the demand filed with the International Preliminary Examining Authority on:

24 January 2001 (24.01.01)

in a notice effecting later election filed with the International Bureau on:

2. The election was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Claudio Borton Telephone No.: (41-22) 338.83.38
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10/09/2001
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WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification: C23C 16/00	A1	(11) International Publication Number: WO 00/79019
		(43) International Publication Date: 28 December 2000 (28.12.2000)
(21) International Application Number: PCT/US00/17202		Published
(22) International Filing Date: 23 June 2000 (23.06.2000)		
(30) Priority Data: 60/141,111 24 June 1999 (24.06.1999) US		
(60) Parent Application or Grant GADGIL, Prasad, Narhar [/]; O. SULLIVAN, Stephen, G.; O.		

(54) Title: APPARATUS FOR ATOMIC LAYER CHEMICAL VAPOR DEPOSITION

(54) Titre: DISPOSITIF DE DEPOT CHIMIQUE EN COUCHES ATOMIQUES EN PHASE VAPEUR

(57) Abstract

An atomic layer deposition (ALD) reactor (13) is disclosed that includes a substantially cylindrical chamber (15) and a wafer substrate (22) mounted within the chamber (15). The ALD reactor (13) further includes at least one injection tube (14) mounted within the chamber (15) having a plurality of apertures (32) along one side that directs gas emanating from the apertures (32) towards the wafer substrate (22). While gas is pulsed from the injection tube (14), either the wafer substrate (22) or the injection tube (14) is continuously rotated in a longitudinal plane within the chamber (15) to ensure complete and uniform coverage of the wafer substrate (22) by the gas.

(57) Abrégé

La présente invention concerne un réacteur (13) de dépôt en couches atomiques (atomic layer deposition / ALD) comprenant un compartiment essentiellement cylindrique (15) et un substrat en tranche (22) fixé à l'intérieur du compartiment (15). Le réacteur ALD (13) comprend également au moins un tube d'injection (14) monté à l'intérieur du compartiment (15) doté d'une pluralité d'ouvertures (32) situées le long d'une face, servant à diriger le gaz émanant des ouvertures (32) vers le substrat en tranche (22). Lorsque le gaz est expulsé du tube d'injection (14), soit le substrat en tranche (22), soit le tube d'injection (14) tourne de façon continue dans un plan longitudinal à l'intérieur du compartiment (15) de sorte que le gaz recouvre complètement et uniformément le substrat en tranche (22).

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

REC'D 27 NOV 2001	
1446PCT	PCT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 1446PCT	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/17202	International filing date (day/month/year) 23 June 2000 (23.06.2000)	Priority date (day/month/year) 24 June 1999 (24.06.1999)
International Patent Classification (IPC) or national classification and IPC IPC(7): C23C 16/00 and US Cl.: 118/715; 117/88, 98, 200; 427/255.7; 438/762		
Applicant GADGIL, PRASAD NARHAR		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

- I Basis of the report
- II Priority
- III Non-establishment of report with regard to novelty, inventive step and industrial applicability
- IV Lack of unity of invention
- V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI Certain documents cited
- VII Certain defects in the international application
- VIII Certain observations on the international application

Date of submission of the demand 24 January 2001 (24.01.2001)	Date of completion of this report 24 October 2001 (24.10.2001)
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Jeffrie R. Lund SOPHIA THOMAS JULIE L. LEE, SPECIALIST Telephone No. (703) 308-0661

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/17202

I. Basis of the report

1. With regard to the elements of the international application:*

the international application as originally filed.

the description:

pages 1-21 as originally filed

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

the claims:

pages 22-27, as originally filed

pages NONE, as amended (together with any statement) under Article 19

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

the drawings:

pages 1-13, as originally filed

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

the sequence listing part of the description:

pages NONE, as originally filed

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

the language of publication of the international application (under Rule 48.3(b)).

the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

contained in the international application in printed form.

filed together with the international application in computer readable form.

furnished subsequently to this Authority in written form.

furnished subsequently to this Authority in computer readable form.

The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

the description, pages NONE

the claims, Nos. NONE

the drawings, sheets/fig NONE

5. This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/17202

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N) Claims 4-7, 9, 11-33 YES
 Claims 1-3, 8, 10 NO

Inventive Step (IS) Claims 4-6, 13-17, 21-25, 27-33 YES
 Claims 1-3, 7-12, 18-20, 26 NO

Industrial Applicability (IA) Claims 1-33 YES
 Claims NONE NO

2. CITATIONS AND EXPLANATIONS

Please See Continuation Sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

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Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:

Claims 4-6, 13-17, 21-25, 27-33 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest the gas injector of claims 4-7, the method of injecting gas of claims 13-17 and 21-25 and the apparatus of claims 27-33, specifically the gas injection system.

Claims 1-33 meet the criteria set out in PCT Article 33(4) in that they have industrial applicability in the manufacture of semiconductor devices. Claims 1-3 lack novelty under PCT Article 33(2) as being anticipated by Aucoin et al, US Patent 5,443,647. Aucoin et al teaches the claimed invention in figure 1 and column 3 line 9 through column 4 line 11.

Claims 1-3 lack novelty under PCT Article 33(2) as being anticipated by McMillan et al, US Patent 5,456,945. McMillan et al teaches the claimed invention in figure 1.

Claims 1-3, and 10 lack novelty under PCT Article 33(2) as being anticipated by Brors et al, US Patent 5,551,985. Brors et al teaches the claimed invention in figures 4, 5A, 5B, 7, and 9; and throughout the specification.

Claims 1-3, and 8 lack novelty under PCT Article 33(2) as being anticipated by Chyi, US Patent 5,637,146. Chyi teaches the claimed invention in figure 1, 3a, 3b, and 3c and throughout the specification.

Claims 1, 2, and 9 lack novelty under PCT Article 33(2) as being anticipated by van Os et al, US Patent 5,792,272. Van Os et al teaches the claimed invention in figures 2 and 4.

Claim 7 lacks an inventive step under PCT Article 33(3) as being obvious over Aucoin et al. Aucoin et al teaches a reactor with a cylindrical chamber, a rotating substrate mount to hold a substrate, and a gas injection tube. Aucoin et al differs from the present invention in that Aucoin et al does not teach a cross-shaped injection tube. Cross-shaped injection tubes are known in the art. Furthermore, the specific shape of the gas injection tube is an obvious design feature. The motivation for using a cross-shaped injector is to provide an alternate and equivalent means of injecting the gas. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the injection tube in the form of a cross.

Claims 11, 12, 19, and 20 lack an inventive step under PCT Article 33(3) as being obvious over McMillan et al, US Patent 5,456,945, in view of Gadgil et al, US Patent 5,879,459. McMillan et al teaches a reactor that includes a gas inlet parallel to the substrate that injects gas towards the substrate. McMillan et al differs from the present invention in that McMillan et al does not teach a method in which a first reactive gas is injected into the reactor followed by an inert gas, a second reactive gas, and finally the inert gas again. Gadgil et al teaches a method in which a first reactive gas is injected into the reactor followed by an inert gas, a second reactive gas, and finally the inert gas again. The motivation for using the method of Gadgil et al in the apparatus of McMillan et al is

INTERNATIONAL PRELIMINARY EXAMINATION REPORTInternational application No.
PCT/US00/17202**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

use the apparatus of McMillan et al to deposit alternating layers as taught by Gadgil et al. Therefore it would be obvious to one of ordinary skill in the art at the time the invention was made to use the method of Gadgil et all in the apparatus of McMillan et al.

Claims 11, 12, 18-20, and 26 lack an inventive step under PCT Article 33(3) as being obvious over Chyi, US Patent 5,637,146, in view of Gadgil et al, US Patent 5,879,459. Chyi teaches an inverted reactor that holds the substrate face down and includes a gas inlet parallel to the substrate that injects gas up towards the substrate. Chyi differs from the present invention in that Chyi does not teach a method in which a first reactive gas is injected into the reactor followed by an inert gas, a second reactive gas, and finally the inert gas again. Gadgil et al teaches a method in which a first reactive gas is injected into the reactor followed by an inert gas, a second reactive gas, and finally the inert gas again. The motivation for using the method of Gadgil et al in the apparatus of Chyi is to use the apparatus of Chyi to deposit alternating layers as taught by Gadgil et al. Therefore it would be obvious to one of ordinary skill in the art at the time the invention was made to use the method of Gadgil et all in the apparatus of Chyi.

----- NEW CITATIONS -----

US 5,792,272 A (VAN OS et al) 11 August 1998, see figure 2 and 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/17202

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :C23C 16/00.

US CL :118/715; 117/88. 98. 200; 427/255.7; 438/762.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 118/715; 117/88. 98. 200; 427/255.7; 438/761. 762; 428/543.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,443,647 A (AUCOIN et al) 22 August 1995, entire document.	1 -----
---		2, 3, 5, 6, 8, 11, 12, 19, 20, 27, 28, 30-32
Y		
X	US 5,456,945 A (McMILLAN et al) 10 October 1995, col. 8 line 47 through col. 10 line 61, figure 1.	1 -----
---		2, 3, 5, 6, 9, 11, 12, 19, 20.
Y		
X	US 5,551,985 A (BRORS et al) 03 September 1996, entire document.	1 -----
---		2, 3, 5, 6, 10, 11, 12, 19, 20, 33
Y		

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

02 OCTOBER 2000

Date of mailing of the international search report

18 OCT 2000

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/17202

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,637,146 A (CHYI) 10 June 1997, entire document.	1
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Y		2, 3, 5, 6, 9, 11, 12, 18-20, 26
X	US 5,716,484 A (BLACKBURN et al) 10 February 1998, entire document.	1
---		-----
Y		2, 5, 6, 11, 12, 19, 20
Y	US 5,879,459 A (GADGIL et al) 09 March 1999, entire document.	11, 12, 19, 20

INTERNATIONAL SEARCH REPORT

International application No. PCT/US00/17202

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

USPAT. EPOABS. JPOABS. DERWENT. IBM TECH. DATABASE

search terms: gas\$3, inject\$6, reactive, process, inert, purge, atomic layer deposition, ALD atomic layer epit\$4, rotat\$4, coat\$3, deposit\$3